December 14, 1899.

Dr. G. J. STONEY, Vice-President, in the Chair.

A List of the Presents received was laid on the table, and thanks ordered for them.

The Right Hon. Lord Justice Romer, a member of Her Majesty's Most Honourable Privy Council, was balloted for and elected a Fellow of the Society.

The following Papers were read :—

I. "The Piscian Stars." By Sir NORMAN LOCKYER, F.R.S.

II. "On the Origin of certain Unknown Lines in the Spectra of Stars of the β Crucis Type, and on the Spectrum of Silicon." By JOSEPH LUNT. Communicated by Dr. GILL, F.R.S.

III. "A Note on the Electrical Resistivity of Electrolytic Nickel." By Professor J. A. FLEMING, F.R.S.

IV. "Investigations on Platinum Thermometry at Kew Observatory." By Dr. C. CHREE, F.R.S.

V. "Observations on the Morphology of the Blastomycetes found in Carcinomata." By Dr. K. W. MONSARRAT. Communicated by Professor SHERRINGTON, F.R.S.

The Society adjourned over the Christmas Recess to Thursday, January 18, 1900.

"On the Origin of certain Unknown Lines in the Spectra of Stars of the β Crucis Type and on the Spectrum of Silicon." By JOSEPH LUNT, B.Sc., F.I.C., Assistant, Royal Observatory Cape of Good Hope. Communicated by DAVID GILL, C.B., F.R.S., Her Majesty's Astronomer at the Cape. Received November 27—Read, December 14, 1899.

In a recent paper "On the presence of Oxygen in the Atmospheres of certain Fixed Stars,"* Dr. Gill calls attention to three unknown lines

* 'Roy. Soc. Proc.,' vol. 65, p. 205.

in the spectra of β Crucis, ε Canis Majoris, and stars of their type, viz., wave-lengths 4552·79, 4567·09, 4574·68.

Mr. McClean had previously also recorded these lines in his measures of the spectrum of β Crucis* as wave lengths 4552·6, 4567·5, 4574·5, but beyond pointing out the approximate coincidence of the first of these with lines due to barium or titanium, he assigns no origin to them.

Sir Norman Lockyer frequently records them as unknown lines. In his recent paper "On the appearance of the Cleveite and other New Gas Lines in the Hottest Stars" (June, 1897),† he records all three lines as unknown. The first occurs in a map of the spectrum of Bellatrix as a line in a probable new series found by Dr. W. J. S. Lockyer. The second and third lines, given as 4566·8 and 4574·8, occur in a Table of Lines which Sir Norman regards as belonging, with high probability, to gaseous substances which have yet to be discovered.

It will be noticed that the connection existing between the three lines is not there recognised.

In none of the Tables of Wave-Lengths available for reference at the Cape could any satisfactory clue be obtained as to the origin of the lines.

During some experiments made with a view to securing the best elementary line spectrum of oxygen as a comparison spectrum for stars of the β Crucis type, I found that a tube of carbon dioxide gave the best results, being freer from impurities, and giving stronger oxygen lines than any of the oxygen tubes at my disposal. By the use of a jar and air gap in the secondary circuit of the coil the gas was dissociated, and gave the spectra of carbon and oxygen. During use, the carbon dioxide tubes became more vacuous, and, with a view to obtaining a brighter discharge and shorter exposure, I passed the induced current from an 18-inch Apps' coil, using four large jars and an air gap.

Whilst using these electrical conditions, I happened to expose an argon tube marked 2 mm. (pressure), and on developing the photograph was much surprised to find that it, too, gave the well-recognised lines of oxygen. Stronger than these I at once noticed two lines at the green end of the spectrum, which recalled the lines in β Crucis, which were unknown terrestrially, whilst the expected argon spectrum was almost entirely absent.

On comparing the negative, film to film, with one of β Crucis, and allowing for the difference of temperature conditions under which the two negatives were taken, the identity of the three unknown lines in β Crucis with three lines on the argon negative was at once apparent,

* 'Spectra of Southern Stars' (Stanford, 1898), p. 13.

† 'Roy. Soc. Proc.,' vol. 62, p. 60.

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and a subsequent photograph of the spectrum of ϵ Canis Majoris, in which the argon tube was used, as stated, as a comparison spectrum, established their absolute identity both as regards position and relative intensity.

It was, therefore, evident that a terrestrial source of the three unknown lines had been discovered, and with the behaviour of the carbon dioxide tube fresh in mind, and the replacement of the argon spectrum by unknown lines and those of oxygen by use of a highly disruptive spark, it is not surprising that an obvious startling explanation as to the nature of the element thus found terrestrially should have suggested itself.

It was at first assumed, erroneously as it afterwards proved, that the origin of the unknown lines lay in the gaseous contents of the argon tube. Four argon tubes in succession gave precisely the same results, viz., the argon spectrum with an ordinary discharge and the unknown lines and oxygen, together with the disappearance of the argon spectrum, as a result of using the jars and air gap. On communicating these results to Dr. Gill, he at once interested himself in the matter, and gave every facility for a further prosecution of the inquiry. He remembered that Professor Ramsay had furnished him with a specimen tube of pure argon, and this tube had not been examined. On trying this tube under the same conditions as the others, it was found to give the argon spectrum under all conditions. Neither the unknown lines nor oxygen made their appearance, even when the most intense disruptive spark available was employed.

The first four tubes had aluminium electrodes, whilst Professor Ramsay's tube had platinum electrodes, and was more vacuous and much shorter.

A pair of aluminium electrodes was then taken from a vacuum tube, and a spark between the metal terminals in air was next examined, with the result that the unknown lines were not found. A line appeared very approximately in the same position as the strongest of the three lines, but this was only one of the numerous air lines, and was due to nitrogen (4552·6 Neovius). Therefore, the electrodes of the argon tubes did not account for the unknown lines.

On a further examination of the negatives, the H and K lines of calcium were recognised in the spectra of the argon tubes subjected to the highly disruptive spark, pointing to the fact that the lime of the glass was being volatilised.

This fact alone might account for the presence of the oxygen lines in the spectra, and the materials of the glass were then suspected as being the origin of the lines under consideration.

A tube of pure helium, kindly furnished to Dr. Gill by Professor Ramsay, was next examined, and, with much surprise, this was found also to behave exactly as the first argon tubes had done.

With an ordinary discharge it gave the pure helium spectrum, but with the highly disruptive discharge the helium spectrum *vanished entirely*, and was replaced by the unknown lines and the spectrum of oxygen. The helium spectrum could be obtained at will by reverting to the ordinary discharge.

This helium tube had platinum electrodes, and these last observations finally banished any idea that the gaseous contents of the tubes or the metallic electrodes could be the origin of the substance searched for, and the conclusion that the glass of the tubes contained the substance sought was now irresistible. Yet in some of the spectra from the helium tube, the H and K lines of calcium were absent when those of oxygen were present, showing that the lime of the glass did not necessarily account for the presence of oxygen.

After various fruitless experiments, sparks were taken between the platinum terminals of a broken up vacuum tube on which still adhered some of the blue fusible glass, commonly used in sealing in platinum wire in glass. The spectrum of this spark in air showed the unknown lines.

Beads of glass made from ordinary soda glass tubing, were then fused on platinum wires, and the spark from these was examined. The unknown lines again appeared. The substance sought was now strongly suspected to be the element silicon. The siliceous diatomaceous earth "kieselguhr" was next used as the most convenient source of silica, and beads of sodium silicate were made by fusing this material with sodium carbonate on platinum wire. The result of the examination of the spark was that the unknown lines were again found. The next step was to replace the kieselguhr by pure rock crystal obtained from the South African Museum by Dr. Gill. Sodium silicate made from the pure rock crystal, also furnished the unknown lines, whilst the sodium carbonate alone failed to give them.

These experiments left little room for doubt that the element sought was silicon. Nevertheless, it was very desirable to confirm the result in another way, by examining the spectrum of a gaseous siliceous compound.

Platinum wires were sealed into the ends of a piece of wide glass tubing, $\frac{5}{8}$ inch internal diameter, the ends of the wires leaving a gap of only $\frac{5}{8}$ inch for the passage of the spark. The tube was also furnished with an inlet and outlet tube for the gas. No capillary tube was used in order to avoid the hot spark coming into direct contact with glass. The tube was then filled with silicon tetrafluoride, and after the gas had been passing for some time, it was sealed off at atmospheric pressure.

An ordinary discharge passed through the gas without jars or air gap gave a banded spectrum of the compound itself.

The disruptive discharge obtained by using four jars and an air gap,

at once gave the unknown lines, which were thus proved to be undoubtedly due to silicon.

This silicon spectrum was not accompanied by that of oxygen, thus proving that it could not be due to any dissociation of the silica of the glass, and that in this case, the gaseous contents of the tube and not the tube itself, furnished the lines under consideration.

Sir Norman Lockyer's papers were then consulted for any reference to the presence of silicon in stars, and it is necessary to refer in some detail to his observations. It is evident that he has used similar powerful disruptive discharges with vacuum tubes, and obtained partial decomposition of the glass, for he says :* "The use of the spark with large jars in vacuum tubes results in the partial fusion of the glass, and the appearance of lines which have been traced to silicium."

Unfortunately he does not give the wave-lengths of the lines thus traced to silicon, and from his statement alone, one would surmise that the origin of the three lines was recognised by Lockyer.

There is evidence, however, *in the same paper* that he cannot have traced the lines in question to silicon notwithstanding the above statement, because, as previously pointed out, Sir Norman regards two of the lines as belonging to gases yet undiscovered, and includes them in a Table of Wave-Lengths of lines due to unknown *gases.*

The other line he also includes as an unknown line in Bellatrix, and Dr. W. J. S. Lockyer places this as a member of a probable rhythmic series due to an unknown substance.

It is a curious fact that Hartley and Adeney, and Eder and Valenta, who alone give us any extended list of lines due to silicon, appear not to have examined the spectrum of this element in the region of the three lines here considered. Their published wave-lengths show only lines in the extreme ultra-violet, and the majority of them are quite outside the region which can be examined by the McClean Star Spectroscope.

Watts's 'Index of Spectra' (Appendix E, p. 21) records a line at 4566 (Salet), but no lines appear corresponding to 4552·79 and 4574·68.

Sir Norman Lockyer† regards two lines at 4128·6 and 4131·4 as the most conspicuous enhanced lines of silicon, indeed these two lines are the only silicon lines he labels Si in his published photographs. Eder and Valenta give 4131·5 and 4126·5 as the least refrangible on their list, and although there is a rather excessive discrepancy in the wave-lengths of one of the lines, they are probably the same pair of lines. They are shown in Lockyer's photographs of the spectra of α Cygni and Sirius‡ and also of α Cygni and Rigel.§

* 'Roy. Soc. Proc.,' vol. 62, 1897, p. 65.
† 'Roy. Soc. Proc., vol. 61, 1897, p. 443.
‡ 'Roy. Soc. Proc.,' vol. 65, p. 191.
§ 'Phil. Trans.,' A (1893), plate 2.

It is a remarkable fact that these three stars, which may be considered as amongst the best examples of silicon stars in the light of the spectrum of silicon hitherto known, *do not show* the three silicon lines which are so prominent in β Crucis, ϵ Canis Majoris, &c. Scheiner has measured the spectra of all three stars* in this region, but does not record the lines in his Table of Wave-Lengths.

Their absence from the spectra of these stars (as well as the presence of Lockyer's enhanced silicon lines) is fully confirmed by photographs taken here with the special object of searching for the new silicon lines in the best known silicon stars.

This can be readily understood in the light of the experiments with the tube of silicon tetrafluoride.

With the highest disruptive spark, Lockyer's silicon lines 4128·6 and 4131·4 are much enhanced as compared with the lines 4552·79, 4567·09, 4574·68, and it was found possible by suitable exposure to obtain the two enhanced lines without the presence of the other three lines becoming evident.

The latter lines would be much more rapidly obliterated in the absorption spectra of stars, than in the bright line spectrum from the tube, and therefore their absence from certain stars in which the enhanced lines are strong need not occasion much surprise.

In other stars, however, all five lines are present. Lockyer has recorded them in Bellatrix and their presence has been confirmed by photographs of the spectrum of this star taken here. Mr. McClean has measured all five lines in β Crucis where Lockyer's enhanced silicon lines are certainly not so conspicuous as the lines 4552·79 and 4567·09.

The same may be said of ϵ Canis Majoris in which star the new silicon lines are very prominent, whilst the enhanced lines are very faint.

In the silicon spectrum from the argon and helium vacuum tubes, the enhanced lines noted by Lockyer are by no means so prominent as they are in the silicon spectrum, obtained from silicon tetrafluoride with the intense disruptive spark. It is evident, therefore, that great variations in the relative intensities of the silicon lines occur in stellar spectra, and that such variations can be produced to a certain extent in the laboratory, and these require further investigation.

The behaviour of the silicon lines will give us valuable data for the elucidation of the problem of relative stellar temperatures.

It is clear that if we regard, with Lockyer, the lines 4128·6 and 4131·4 to be the enhanced lines of silicon and their presence, enhanced, to be a criterion of a higher temperature than occurs in stars where these lines are *not* enhanced, it must follow that such stars as α Cygni, Rigel, and Sirius are hotter than Bellatrix, β Crucis, and ϵ Canis

* Scheiner's 'Astronomical Spectroscopy.'

Majoris. Whereas Lockyer* in his most recent paper "On the Chemical Classification of the Stars" (April, 1899), regards the so-called "Crucian" stars, as at a higher temperature than the "Rigelian" and "Cygnian," and indeed he regards Bellatrix "as a type of the hottest stars, exception being made of ζ Puppis."

Of the other lines recorded by Eder and Valenta† as due to silicon, 3905·4, 3862·5 and 3855·7 are present both in the spectra of the dissociated glass and in the high temperature spectrum of silicon obtained from the silicon tetrafluoride tube.

They are enhanced lines in the latter case, occurring together with Lockyer's enhanced lines in the absence of the three new silicon lines, but they lie outside the region measured by Scheiner in α Cygni, Sirius, and Rigel.

In the Harvard "Spectra of Bright Stars"‡ the two latter lines are however, specially noted in Rigel as 3863·2 and 3856·2 as "conspicuously strong in the ultra-violet," whilst all three are recorded (3905·6, 3863·2, 3856·2) in stars of Groops VI to VIII (Harvard), comprising α Cygni, Sirius, and Rigel. They would thus appear in these stars to accompany the enhanced silicon lines, specially noted by Lockyer, viz. 4128·6 and 4131·4.

The lines 3834·4 and 3836·7 recorded by Eder and Valenta are not present in any of the photographs of silicon spectra, and may possibly be due to impurities.

The lines 3795·9 and 3791·1 recorded by Eder and Valenta are present in all the silicon photographs, but do not become enhanced at high temperatures. There is, however, a third line, approximately λ 3807, not recorded by them, but which appears in all the photographs of silicon spectra. It is stronger than 3795·9 and 3791·1, and does not become enhanced with high temperature. All three lines accompany the three new silicon lines in ϵ Canis Majoris.

"A Note on the Electrical Resistivity of Electrolytic Nickel." By J. A. Fleming, M.A., D.Sc., F.R.S., Professor of Electrical Engineering, University College, London. Received November 21,—Read December 14, 1899.

The numerical values assigned by various experimentalists for the mass or volume electrical resistivity of certain metals differ very considerably. Some metals are without much difficulty prepared as often

* 'Roy. Soc. Proc.,' vol. 65, No. 416, p. 189.

† Watts's 'Index of Spectra.'

‡ 'Harvard Annals,' vol. 28, Part I, Table 7, p. 23.